

condition of a peace which is more than an armistice must be found in a democratic form of government. The subsequent steps will be arbitration tribunals, disarmament, and an international parliament. These seem far enough off at present, but it is important to make up our minds whether we really desire them, and if not, why not. Prof. Jastrow's wisely written book—careful and restrained throughout—makes for illumination.

The Strategic Geography of the Great Powers. (Based on a Lecture delivered during 1917 to Officers of the Grand Fleet and of the British Armies in France.) By Dr. Vaughan Cornish. Pp. viii+114. (London: George Philip and Son, Ltd., 1918.) 2s. net.

WITHIN the compass of a small volume Dr. Vaughan Cornish has tried, not unsuccessfully, to crowd many ideas. He describes the great States of the world as regards their sources of men and materials, and the lines of communication by which force can be concentrated. His point of view is often fresh and always geographical. The distribution of the British Empire is described, not by continents, but by oceans. The old system merely emphasises the gaps in continuity of the Empire. Dr. Cornish's method indicates an appreciation of the ocean as a highway linking together the component parts of the Empire. But land routes may also be of importance. In his treatment of Asia Dr. Cornish insists on the strategic value of southern Turkestan and northern Afghanistan as the eventual crossing-place of the chief lines of traffic from Moscow to Delhi, and from Constantinople, Cairo, and Bagdad to Peking.

The volume has small coloured maps of Europe, Asia, and the world. The last, on a Mercator projection, would have been a better illustration of the chapters if it had been on an equal-area projection. Dr. Cornish's work is an excellent introduction to the geographical conditions of national security, and should be widely read.

B.S.A. Musketry Score Book for Use in the General Musketry Course. Instructions for Short Lee-Enfield Rifle and Enfield Pattern 1914 Rifle, Using Mark VII. Ammunition. By E. J. Smyth. Pp. 47. (London: Forster Groom and Co., Ltd., 1918.) Price 3d. net.

THIS excellent little book is a combination of a book of instruction and a score record. It contains clear instructions for the sighting to be employed at higher ranges after making a group at 100 yds., so that the error of the rifle may be obtained without the long experience with the individual rifle which is desirable but cannot always be obtained. The instructions for the short Lee-Enfield rifle and for the Enfield pattern 1914 are placed together, but are indicated by distinctive borders so that no confusion can arise. The book should prove particularly useful to every Volunteer in order to enable him to know the behaviour of his own rifle on the completion of his musketry course. It is also a most useful guide to the course itself.

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LETTERS TO THE EDITOR.

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The Perception of Sound.

As I had the privilege of being consulted by Sir Thomas Wrightson during the later years of his "Inquiry into the Analytical Mechanism of the Internal Ear," and advising him as regards the physical nature of the cochlea and the arrangement of its parts, I may be allowed to try to clear up the various objections formulated by Prof. Bayliss (NATURE, October 17, p. 124), as they chiefly concern matters relating to anatomy or physiology. When Prof. Bayliss looks again at the title of Sir Thomas Wrightson's work, which I have quoted above, he will see that he is in error in supposing that the Wrightson theory deprives the cochlea of the analytical function postulated by Helmholtz. Helmholtz's theory presupposes that the cochlea contains an extensive series of resonators for resolving a sound complex into its component waves; Sir Thomas Wrightson's theory presupposes that the cochlea is a machine designed for the purpose of analysing sound complexes and of registering its component waves as nerve impulses. I fear it is a loose statement of mine on p. 159 of the Appendix to Sir Thomas Wrightson's book that has misled Prof. Bayliss; there I have written that "the final analysis must be done in the cortex of the brain even if Helmholtz's theory is true." That I still believe to be the case.

Prof. Bayliss demurs to the opinion I have expressed that no theory of the mechanism of the ear can be regarded as satisfactory that fails to explain the form and the arrangement of its various parts. I have found that to be an absolutely infallible law as regards every part of the animal body concerned in movement: In every bone, joint, muscle, tendon, and ligament which has been investigated the result has been the same—the material of which each is made has been found to be so placed, so shaped, and so arranged as to carry out the particular function which has been assigned to it. Whether we accept Helmholtz's explanation of the mechanism of the internal ear or Sir Thomas Wrightson's, we are dealing with a machine concerned in movement, and it is, therefore, legitimate to infer that its parts are designed to subserve its various movements. The only structural feature of the cochlea explained by Helmholtz's theory is the gradual increase of the basilar membrane from its proximal or fenestral end to its distal or helicotrema end. The elaborate structure of the organ of Corti and the conformation of the canals of the cochlea are left unexplained, whereas in Sir Thomas Wrightson's theory all these matters receive a rational explanation. On the Helmholtz theory we must believe that the rabbit is provided with a more delicate analytical machine than man, and the sloth with a more elaborate one than the most tuneful bird. Nay, we are certain that if Helmholtz's explanation had been the right one, Nature could have secured the necessary mechanism in a much simpler way, namely, by providing the auditory hair-cells with processes or cilia of the requisite qualities and dimensions to serve as sympathetic resonators.

I now come to a very important and very difficult objection that has been raised by Prof. Bayliss. Sir Thomas Wrightson's theory certainly presumes that the fibres of the nerve of hearing are capable of carrying

5000, 20,000, 40,000, or more impulses per second. He rightly says we have no experimental evidence that a nerve can convey at the utmost more than 500 impulses per second. He quotes the investigations of the late Dr. Keith Lucas, but Keith Lucas was careful to point out ("The Conduction of the Nerve Impulse") that his work had been necessarily confined to the motor nerves of muscles, and was clearly of the opinion that his results were not transferable to sensory nerves, particularly in the case of light and sound." Indeed, on Helmholtz's theory we infer, and are justified in the inference, that certain fibres of the auditory nerve must be capable of carrying at least 18,000 impulses per second—if we accept that number as the upper limit of our range of hearing. In Sir Thomas Wrightson's theory it is necessary to presume that every hair-cell is capable of generating, and every auditory fibre of conducting, at a rate which may vary from 60 per second to 80,000 per second. I anticipate that the internal ear will provide psychologists with the most delicate means of investigating the manner in which sensory stimuli are produced by mechanical means.

Instead of Helmholtz's theory being in conformity with Müller's law, and Sir Thomas Wrightson's at variance with it, I am of opinion that the opposite is the case. In consequence of having adopted the theory of resonators, Helmholtz had to make the further assumption that the auditory differed from every other sensory nerve—such as those of touch, taste, and smell—in that its fibres were specialised into 15,000 or more units or groups, whereas in ordinary sensory nerves there is no such specialisation, every one of its fibres being capable of serving the same kind of function. The only exception is the optic nerve, in which Young and Helmholtz postulated at least three kinds of units or fibres. The recent investigations of Dr. F. W. Edridge-Green and of Dr. R. A. Houston tend to prove that there is no need to postulate a functional differentiation in the fibres of the optic nerve, and similarly the Wrightson theory does away with the necessity for presuming that the auditory nerve contains 15,000 sets of fibres which are functionally distinct.

No reference was made by Sir Thomas Wrightson to experiments which had demonstrated that animals subjected to a prolonged repetition of a note of a high vibrational frequency suffer a degeneration at the narrow, proximal or fenestral end of the organ of Gorti—just the area which we may presume would be affected if the theory of Helmholtz were true. Nor was allusion made to the less certain results obtained at the opposite end of the organ by prolonged repetition of notes of low frequency. From the measurements and data which I placed before Sir Thomas Wrightson, he estimates that in all stapedial movements pressure falls simultaneously and equally on all parts of the basilar membrane, but of this I am not convinced, conceiving that notes of high frequency, especially where the waves rise sharply to their maximum intensity, will fall chiefly on the proximal or narrow end of the basilar membrane, whereas notes of low frequency, rising slowly to their maxima, will fall chiefly on the distal or wide end of the membrane. If such is the case, then it is not necessary to invoke Helmholtz's theory for their explanation. The explanation is not a new one, having been put forward by Prof. Max Meyer, of the University of Missouri, a number of years ago.

There are also the cases observed by aural surgeons where tone-gaps or islands occur in the gamut of hearing. These cases receive an apparent explanation on the Helmholtz theory. I think it will be found that such cases represent defects in the auditory

system corresponding with colour-blindness in the visual system, both representing disorders, not in the peripheral, but in the central, parts of the auditory and visual systems. I would direct particular attention to a statement made by the late Keith Lucas on the last page (p. 102) of his posthumous work on "The Conduction of the Nervous Impulse":—"On the basis of this analysis we have pictured the central nervous system as a network of conductors having different refractory periods, communicating through regions of decrement, easily fatigued." A network of conductors having different refractory periods presents the exact mechanism needed for the sorting out of the millions of impulses which reach the auditory centres along the fibres of the auditory nerve. Sir Thomas Wrightson has shown that, however complex the sound, each component part is registered by the hair-cells as the complex passes through the inner ear. Keith Lucas's speculations open up the possibility of a central machine for assorting the impulses according to their time-intervals.

I, for one, am particularly glad that Prof. Bayliss has taken an interest in this matter, because his knowledge of that borderland which lies between physics and physiology peculiarly fits him to adjudicate on the claims of the Helmholtz and of the Wrightson theories of the internal ear.

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Epidemic Influenza.

PROF. HEWLETT'S interesting article in NATURE for October 24 may justify the statement of a few facts collected during the last quarter of a century. Dealing with the Registrar-General's returns for London and considering twenty deaths per week as epidemic if this number or more is maintained for successive weeks, there have been twenty-eight epidemics since the reassertion of the complaint in 1890. Of these there have only been two, in the years 1910 and 1911, with fewer deaths than 100. The only years in the epoch without influenza being epidemic are 1896 and 1901. The most serious epidemics since 1890 occurred in 1891, 1892, and 1899-1900, in each of which there were in London upwards of 2000 deaths. In recent years the most serious epidemic occurred in 1908 with a total of 1061 deaths, but the summer and autumn epidemics of the present year bid fair to be at least as severe.

The two epidemics of the present year differ very materially from all the other epidemics since 1890 with respect to the age-death. The Registrar-General has introduced a slight change in the returns from 1911, which prevents 40 being uniformly adopted as an age limit for death. Taking all the epidemics from 1890 to 1916-17, the deaths at ages from 0 to 20 years were 12 per cent. of the total number; from 20 to 40 or 45 years, 14 per cent.; and from 40 or 45 years and upwards 74 per cent. These numbers are remarkably similar in the several epidemics. For the two epidemics this year the deaths for the respective ages are 0 to 20 years, 26 per cent.; 20 to 45 years, 48 per cent.; and above 45 years, 26 per cent. It is an interesting problem to account for the difference introduced in the ages of death in the epidemics of the present year.

Prof. Hewlett refers to the disease waning and almost disappearing after the epidemic of 1893-94, but an examination of the Registrar-General's returns will show that the epidemics were exceptionally severe in 1895, 1899, and 1899-1900, and also in 1908, the deaths in London from influenza alone exceeding